

Plant lipid desaturases are enzymes that perform dehydrogenation reactions at precise locations on a long-chain fatty acyl group, resulting in the formation of a carbon-carbon double bond. Catalytically, these reactions are extremely interesting as they are initiated at unactivated C-H functionalities on the substrate, consume molecular O₂, and depend on two iron atoms present in the active site of the enzyme. Functionally, these enzymes play a vital role in providing the unsaturated plant lipids required for the biosynthesis and proper functioning of biological membranes – and the energy transduction systems (like photosynthesis and respiration) that rely on them. In a minireview article featured on the cover of the *Journal of Biological Chemistry* (284:18559-18563), Dr. John Shanklin from Brookhaven National Laboratory and his colleagues summarize recent progress in understanding the structure and function of these enzymes, as well as their molecular evolution. Interestingly, the diiron structural motif at the catalytic center of these enzymes has independently evolved two times, with amino acid homologies and primary ligation spheres distinguishing the two ancestral forms. The recent availability of crystal structures for several of these enzymes and the detailed studies of substrate specificity and product formation arising from numerous structural variants are providing critical insights into how relatively minor changes in protein structure lead to the “tuning” of the diiron cluster. This new understanding offers molecular explanations for the evolutionary appearance of the over 1000 so-called “unusual” fatty acid products (e.g., those with *trans* double bonds, triple bonds, epoxy groups, hydroxyl group, etc) found in nature.